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EVALUATION OF THE IMPORTANCE OF AGE AND GENDER IN THE PATENCY OF UPPER EXTREMITY ARTERIOVENOUS FISTULA IN CHRONIC HEMODIALYSIS PATIENTS

***Bilgehan Erkut and Azman Ates**

Atatürk University, Medical Faculty, Department of Cardiovascular Surgery, Erzurum, Turkey

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ABSTRACT

Background: Arteriovenous fistula is the vascular access of the first choice in hemodialysis. Studies on the patency of the arteriovenous fistula and the influencing factors indicate that there is a high risk for access failure. The patency of arteriovenous fistulas is the primary determinant of the effectiveness of dialysis. ***Methods:*** Between April 2015 and July 2019, 161 patients (78 males, 83 females; mean age 61.1 years; range 35 to 75 years) who underwent AV fistula operation were retrospectively analyzed. The surgical operations were performed by two different cardiovascular surgeons for hemodialysis. The patients were divided into two groups including Group I (patients over 50 years of age; n=83; mean age 61.4 years) and Group II (patients under 50 years of age; n=78; mean age 60.8 years). Primary patency was the time interval between arteriovenous fistula creation and its first thrombosis and any intervention for recanalization. The effects of age and gender on primary patency rates were investigated in both groups. ***Results:*** In terms of arteriovenous fistula patency, primary fistula patency was lower in male patients. In addition, fistula patency was lower in Group I patients than in Group II patients during 5 years of follow-up ($p<0.001$). ***Conclusion*:** Arteriovenous fistula patency rates were lower in male patients over 50 years of age. The older age and male gender were found to be factors affecting the primary patency of arteriovenous fistulas.

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INTRODUCTION

The number of patients undergoing hemodialysis is increasing gradually throughout the world. There is a need for arteriovenous fistulas (AVFs), which are less complicated and that may remain open for long periods of time due to increases in the comorbidity of dialysis patients and the life expectancy of patients. The increase in the number of patients naturally increases the surgical interventions due to recurrent interventions associated with AVFs. A large number of patients who need dialysis cannot become kidney transplant candidates (Erkut, 2006; Rocco, 1996). The average number of hospital days per year for hemodialysis patients is 11.2. Complications due to vascular interventions and vascular disruptions due to recurrent interventions are the major cause of patient-related morbidity (Rocco, 1996; Chazan, 1990). For hemodialysis patients, any vascular intervention is of limited duration and each patient has a limited number of access sites for vascular intervention. In 1966 Brescia *et al*. (1996) provided groundbreaking applications and this arteriovenous fistula-like shape created a great convenience in terms of hemodialysis patients. Since then, it has begun to be used in almost all hemodialysis patients and is still being used as the first choice (Rocco, 1996; Brescia *et al*., 1966). The vital element for these patients is the long-term provision of the AVFs patency as much as possible. There are a number of factors affecting the patency or occlusion of AVFs. In this study, we tried to determine whether advanced age and gender affect for primary fistula patency.

MATERIALS AND METHODS

From April 2015 through July 2019, 161 patients underwent arteriovenous access for hemodialysis in Atatürk University Cardiovascular Surgery Clinic.

Of the patients operated for AVF, 78 (48,4 %) were male and 83 (51,6 %) were female. Their mean age was 61.1 years (range 35 to 75 years). The patients were divided into 2 groups. Patients over 50 years of age were considered as Group I (n=83; mean age 61.4 years) and patients under 50 years of age were considered as Group II (n=78; mean age 60.8 years). We collected the following parameters at the time of creating the AVF: demographics (age and gender), comorbidities (hypertension, diabetes, peripheral arterial disease, hypercholesterolemia, obesity, smoking, etc.). All preoperative data are shown in Table-1. The patients were prospectively followed up for 4.2 ± 1.1 years (mean 3.2 years). Patients were followed up for kidney transplantation or death. The effects of age and gender on primary patency rates of both groups were investigated. Primary patency was the interval from the time of access placement until any intervention designed to maintain or re-establish patency, until access thrombosis, or until the time of measurement of patency.

Exclusion criteria: Patients with coronary artery disease, congestive heart failure, pregnancy, chemotherapy for malignant disease, hereditary thrombotic tendency, trauma to the upper extremity, orthopedic operations and phlebitis, arm-associated venous thrombosis and arterial embolism, ejection fraction below 30 % and vein diameter under 2 mm were not included in the study.

Surgical procedure: The extremity planned to create an AVF was kept away from invasive procedures and trauma. In addition to physical examination, duplex ultrasonography was routinely performed in all patients. For the creation of the AVF, the diameter of the vein was preferred over 2 mm. In patients without this feature, appropriate vein investigations were performed with duplex ultrasonography and venography. All patients in the study were preoperatively treated with a single dose of antibiotics. All patients were operated by the same surgical team. The non-dominant upper extremity, usually the left, was preferentially used. The lower extremity was avoided because of concern for infection, effect of peripheral vascular disease and particularly, patient inconvenience. Generally, AVFs should be performed from distal to proximal, using the patient's own autogenic veins for hemodialysis. Distal AVFs are preferred in order to enlarge the puncture area. After preparation of the artery and vein, 0.5 ml heparin was administered to the patients. The vein was released to increase the fistula flow. Anastomoses were performed by using end-side technique using 7/0 polypropylene. The wound was then closed in a single layer and the hand was kept elevated. After the operation, pulsation, and thrill were evaluated as a successful outcome. The patients were discharged first day after the operation. Anticoagulant treatment of low molecular weight heparin was applied to all patients after 10 days.

Anesthesia: Local anesthesia or axillary block was preferred for surgical intervention. After surgical field asepsia, local anesthesia was performed by using lidocaine (10-15 mL). In patients with axillary blockade, anesthesia was achieved by 5 ml of bupivacaine.

Assessment of fistula maturation: Patients were investigated by an experienced vascular laboratory technician. Preoperative duplex ultrasonography was done within 1 week of the operation with the aid of a 7·5-MHz linear-array transducer. Postoperative assessment of fistula development and function was done by duplex imaging at the time of hospital discharge, and after 3 and 6 months. It was recommended that the wound area should not be traumatized and exercise with finger movements from the second day should be applied to the patients with AVF. Patients had to wait at least 3 weeks for fistula development, expansion of the venous structure and adequate AVF flow.

STATISTICAL ANALYSIS: Student t test was used to compare age between groups, and chi square test was used for gender comparison. Kaplan Meier survival analysis and log rank test were used to assess the obstruction status of the fistula for 5 years. Age-related data were presented with the mean ± standard deviation of the arithmetic mean. Categorical variables were expressed as counts and percentages. Statistically, 0.05 levels were accepted as significant.

RESULTS

The pre-operative data analysis made between both groups is presented in Table-1. There were no differences between two groups in preoperative patients' characteristics. The mean ages were 52.1 ± 3.6 and 50.7 ± 4.5 for Group I and Group II, respectively, and there was no statistical significance. There was no statistically significant difference between the groups in terms of gender and age. The mean age and gender were almost similar. But, there were some differences relation to hypertension, diabetes mellitus and smoking between Group I and Group II, preoperatively.

There were no differences between the two groups in terms of the number of patients with hypertension and diabetes mellitus, but there were differences in the duration of hypertension (years), gender-related hypertension and diabetes mellitus. The hypertension duration was statistically higher in Group I patients, and gender-related hypertension rates were higher in male patients in Group I than Group II. In addition, the rates of gender-related diabetes mellitus were higher in males in Group I patients than Group II. The number of smokers was higher in Group I patients. In addition, the smoking duration was higher in Group I patients and gender-related smoking rates were higher in male patients in Group I (Table-1). There was no difference in terms of numerical and gender between the groups associated with LDL elevation, obesity and chronic obstructive lung disease.

Among our patients, glomerulonephritis (42.2 %), chronic pyelonephritis (21.7 %), polycystic kidney disease and diabetes mellitus were the most frequent causes of end-stage renal disease and hemodialysis indications. There was no statistically significant difference between the groups in terms of the etiology of chronic renal failure (Table-1). In the literature, many types of surgery have been used for AVF. The most common types of surgical intervention to create AVFs were snuff-box, Brescia-Cimino, basilic vein transposition, brachiocephalic, upper radio cephalic (Table-2). There was no statistical difference between the groups in terms of AVFs types. Besides, the information about operations is also summarized in Table 2. The structural and functional properties of AVFs and the complications encountered in the first month postoperatively are summarized in Table-3. The most common complication was hematoma associated with bleeding. The AVFs occlusion was not observed in all patients who were called for control in the first 1 month. All patients successfully performed hemodialysis.

Table 1. The preoperative data for each Group

	Group I (n=83)	Group II (n=78)	P values
Gender (M/F)	41/42	37/41	0.150
Age (mean)	52.1 ± 3.6	50.7 ± 4.5	0.399
Hypertension	48	46	0.309
Hypertension duration (year)	26 ± 5.6	19 ± 6.6	0.001
Gender-related hypertension (M/F)	41/7	33/13	0.001
Smoker habits	49	40	0.001
Smoking duration (year)	29 ± 2.6	22 ± 2.6	0.001
Gender-related smoking (M/F)	40/9	28/12	0.001
Diabetes Mellitus	66	57	0.634
Diabetes mellitus duration (year)	22 ± 2.6	20 ± 2.2	0.109
Gender-related diabetes mellitus (M/F)	55/11	42/15	0.001
Hypercholesterolemia (LDL > 130 mg/dL)	35	33	0.408
Gender-related hypercholesterolemia (M/F)	16/19	18/15	0.891
Obesity (Body-mass index > 30 kg/m^2)	51	49	0.788
Gender-related obesity (M/F)	25/26	24/25	0.344
Chronic obstructive pulmonary disease (COPD)	25	24	0.551
Gender-related COPD (M/F)	12/13	11/13	0.490
Cerebro-vascular disease	4	3	0.770
Peripheral vascular disease	9	8	0.236
Etiology of hemodialysis			
Glomerulonephritis (42.2 %)	32	36	0.122
Chronic pyelonephritis (21.7 %)	17	18	0.453
Polycystic kidney disease (17.4)	15	13	0.422
Diabetes mellitus (8.1 %)	7	6	0.675
Hypertension (6.8 %)	5	6	0.899
Amyloidosis (2.5 %)	2	2	0.590
Other (1.3 %)	1	1	0.233
Evaluation of preoperative venous structure			
Duplex Ultrasound	80	76	0.111
Venography	3	2	0.405

Table 2. The fistula types and operative data between Groups

Variables	Group I (n=83)	Group II (n=78)	p value
Operation time (min.)	62±11	64±12	0.188
Mean vein diameters (mm)	3.2±1.1	3.1±1.2	0.399
Local anesthesia (lidocaine)	70	68	0.509
Axillary blockade (bupivacaine)	13	10	0.388
Used extremity			
Right arm	15	13	0.444
Left arm	68	65	0.871
Fistula types			
Snuff-box	17	16	0.566
Brescia-Cimino	35	31	0.432
Basilic vein transposition	10	12	0.981
Brachiocephalic	13	11	0.521
Upper radio cephalic	8	8	0.433

Table 3. Postoperative parameters and complications of AVF during postoperative and near follow-up period (first month)

Complications and features	Group I (n=83)	Group II (n=78)	P values
Hematoma	41	36	0.533
Bleeding	22	17	0.980
Revision for bleeding	9	8	0.169
Infection	9	11	0.422
Blood flow rate			
Starting Current (200-300 mL/min.)	32	35	0.209
Mature fistula current (800-1200 mL/min.)	49	41	0.116
Over current (>1200 mL/min)	2	2	0.322
AVFs depth from skin surface			
< 0.5 cm	48	49	0.288
0.5-1 cm	29	25	0.188
> 1 cm	6	4	0.280
No surgical intervention			
Distal ischemia	1	1	0.590
Aneurysm formation	2	3	0.809
Steal syndrome	2	2	0.721
Venous hypertension	4	3	0.909
Median nerve injury	2	1	0.701
Thrombosis	0	0	0.100

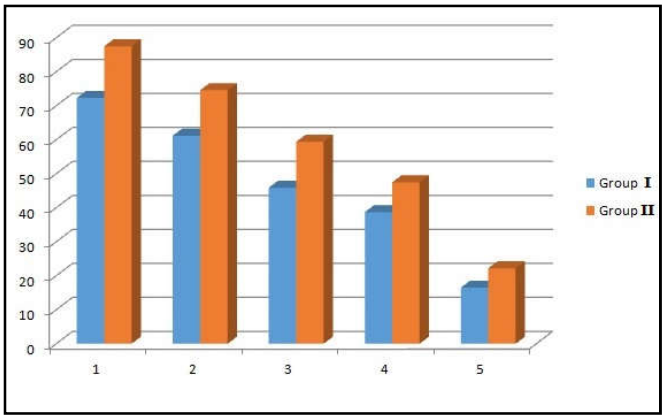

Fig.1. The graph of primary patency rates in the first 5 years between men and women

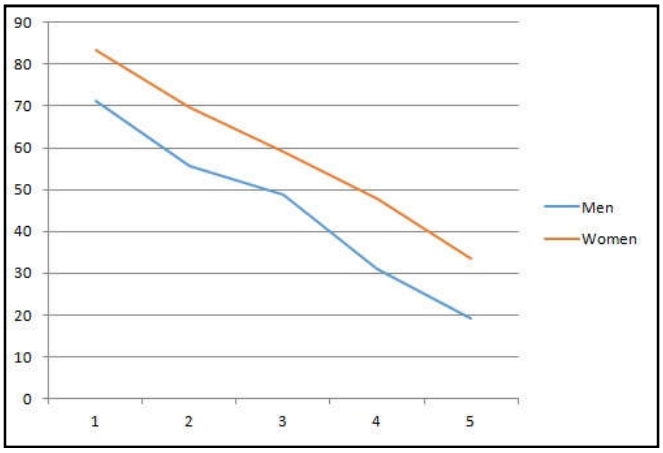

Fig.2. The graph showing primary patency rates between the groups at the end of the first 5 years

There were no statistically significant differences between the groups in terms of the features and complications shown in the Table-3. Evacuation was performed in patients with hematoma. Hemorrhage stopped with minimal compression in hemorrhagic patients. In some patients, the incision of the patient was reopened for bleeding. Bleeding areas were found and bleeding was stopped (ligation or cauterization). We tried to determine the importance of gender in terms of primary patency rates between the 2 groups. The rate of primary patency at the end of the first 5 years was 33.5 % in female patients and 19.2 % in male patients. This result was statistically significant ($p<0.001$) (Fig.1). The overall primary patency rates were 87.5%, 74.6%, 59.4%, 47.5% and 22.2% after 1, 2, 3, 4, and 5 years, respectively, in patients under 50 years of age (Group II). In patients over 50 years of age (Group I), these rates were 72.3%, 61.2%, 45.9%, 38.7% and 16.5% after 1, 2, 3, 4, and 5 years, respectively (Fig.2). There was significant difference between under the age of 50 and over 50 years old relation to primary fistula patency ($p<0.001$). In patients under 50 years of age, the rate of primary patency rates in 5 years was found to be higher than in those aged over 50 years. Besides, mean fistula occlusion was 38.2 months in patients under 50 years of age; this rate was 29.4 months in patients over 50 years of age. This period was statistically significant ($p<0.001$).

DISCUSSION

Patients were followed up between 11 and 52 months (mean 3.9 years) for AVF operations in patients with chronic renal failure.

While this follow-up period was similar to previous studies (Burger, 195=95; Ates *et al*., 2006; Cetinkaya *et al*., 2003), it was shorter than some other studies (Ates, 2006; Chazan, 1995). This evaluation period can be considered as a meaningful time period in terms of the scientific nature of the study. The formation and functioning of the AVFs is an important surgical procedure that is of vital importance for the patient with renal failure and affects the quality of life. Since successful AVF will positively affect the patient's future life, professional AVF clinics serve by coordinated studies in many countries. In some hospitals, AVFs are treated as a surgical procedure in which nephrologists, radiologists and vascular surgeons work together and organize (Erkut, 2006; Ates *et al*., 2006; Cetinkaya, 2003; Chazan, 1995). For the creation of AVFs and long-term patency rates with successful outcomes, surgeons should be made by special interest and follow-up should be done by the same surgeons. Senior surgeons served in the formation of AVFs in our patient groups and patients were followed in their strict follow-up. Starting from the distal region of the upper extremity is still the first method in the creation of AVFs. If this area is not suitable, middle and proximal sections should be started in the arm. In many studies, the patency rates of upper extremity AVFs have been shown in different ratios. Although there was a difference in upper arm and lower arm patency rates,[6,8,9] there was no statistically significant difference in some studies.[10,11] Based on the hypothesis that the AVF patency rates (upper and lower arms) were not different in many studies, we included upper extremity AVFs in our study without upper and lower arm separation.

The most commonly used technique for creating AVFs is the end-to-side technique. In previous years, side-by-side or end-to-end techniques have been used, and over time these techniques have been abandoned. Based on the results obtained in many studies, end-to-side technique has been used more frequently (Brescia, 1966). Although the advantages and disadvantages of all three techniques, because distal ischemia, aneurysms, venous hypertension, stealing syndrome or edema were less common in many studies, we preferred end-to-side technique in all patients (Tautenhahn *et al*., 1994; Astor *et al*., 2000; Sekar, 1993; Harder, 1984) In our series, it was seen that such undesirable situations were very few. The primary purpose for the AVF is to perform the procedure using the forearm. Although the vessel diameters in this region are small, the use of this distal site in case of occlusion and fistula function deterioration provides space for the subsequent creation of new fistula (Marx *et al*., 1990; Glickman *et al*., 2001) In general, the AVF generated for hemodialysis should be performed from the autogenous vascular structures of the patient and from the proximal to the distal (snuff-box, Brescia-Cimino, upper radiocephalic, brachiocephalic). Although there was no consensus on the difference in patency rates of distal AVFs with respect to proximal AVFs, in our patients, we attempted to use the distal site as the first choice for AVFs, considering that there might be fistula distortions after months and years (Erkut *et al*., 2006; Rocco *et al*., 1996; Chazan, 1987; Gibson *et al*., 2001). There was no statistically significant difference with regard to gender and age numbers between the groups. The mean age and gender were almost similar. This result is consistent with the survey of some author, (Goad, 1996) but opposite to the study of the other author (Ates *et al*., 2006; Culp *et al*., 1995; Puskar *et al*., 2002) Although there was no difference in terms of age and gender in general, there were some differences in smoking, hypertension

and diabetes mellitus rates between the groups. Hypertension is one of the most important factors that can cause vascular injury. Negative effects of hypertension on endothelial injury have been shown in the studies. The adverse effects on the AVFs in hemodialysis patients have been proved in many studies (Lazarides *et al*., 1996; Green, 1996; Manne, 2017) However, in some studies, it was also said that it was negligible to affect the fistula patency (Astor *et al*., 2000) Gibson *et al*. (Gibson *et al*., 2001) described an increased risk of revision in diabetic patients, a finding in line with our own observation. Diabetes mellitus may influence the formation of intimal hyperplasia at the anastomosis or venous valve. Manne *et al*. (2017) published an article that suggests that diabetes does not affect fistula patency. Tobacco smoking is a well-known risk factor for vascular disease and arteriosclerosis. The direct link to AVF failure was first described by Wetzig *et al*. (1985) who reported a significantly higher incidence of early and late fistula failure in patients who were cigarette smokers, findings that have since been confirmed by other studies (Monroy-Cuadros, 2010; Smith *et al*., 2012) In our series, smoking, hypertension and diabetes mellitus rates were higher in male patients in Group I. In addition, the duration of smoking and hypertension in Group I was higher than Group II. The rate of patency was lower in male patients and in patients over 50 years of age (Fig.1 and 2). The reason for this was thought to be the effects of smoking, diabetes mellitus and hypertension.

Conclusion

Arteriovenous fistulas for hemodialysis are vital for patients with chronic renal failure, and their preservation and patency is the most important factor. Many factors (demographic, hemodynamic, biological parameters and comorbidities conditions) are effective in maintaining the patency of the fistulas. In this study we investigated the effect of age and gender on AVF patency, and as a result, we found that age and gender are important in the patency of AVFs. Over 50 years of age and male gender adversely affect fistula patency. Smoking, diabetes mellitus and hypertension are some of the most important commodity factors in this outcome.

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